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Report to Congressional Requesters

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AVIATION SAFETY

Measuring How Safely Individual Airlines Operate

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Resources, Community, and
Economic Development Division

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March 18, 1988

The Honorable Barbara Boxer
The Honorable Robert J. Mrazek
The Honorable Mario Biaggi
The Honorable Edolphus Towns
The Honorable Sam Gejdenson
The Honorable Les AuCoin
The Honorable Larry Smith
The Honorable Larry J. Hopkins
The Honorable Lane Evans
The Honorable Howard Wolpe
The Honorable Bruce A. Morrison
House of Representatives

This report, prepared at your request, provides information on areas of importance to airline safety, the availability and quality of data in these areas, and ongoing research on measuring airline safety. Because of increasing concern that airlines may be operating less safely under deregulation, members of Congress, airline executives, and other experts have called for improved ways to measure how safely individual airlines operate. Based on two previous GAO reports, we believe that FAA inspection results have potential for use as measures of airline safety in the areas of pilot competence and maintenance quality if FAA can address current deficiencies.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. We will then send copies to the Chairman, House Committee on Public Works and Transportation; the Chairman, Senate Committee on Commerce, Science, and Transportation; the Secretary of Transportation; the Administrator, Federal Aviation Administration; the Director, Office of Management and Budget; and other interested parties.

This work was performed under the direction of Kenneth M. Mead, Associate Director. Other major contributors are listed in appendix II.

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

The deregulation of airline fares and schedules in 1978 led to rapid growth and change in the airline industry, placing increased burdens on FAA's airline inspection program. Because of growing concern that airlines may be operating less safely under deregulation, members of Congress, airline executives, and other experts have called for improved ways to measure how safely individual airlines operate.

The requesters asked GAO to provide information on the feasibility of developing and publishing for air travelers indicators that compare how safely individual airlines operate. In this request, GAO focused on identifying

- areas of airline performance recognized as important to airline safety,
- the availability and quality of data in these areas, and
- ongoing research on measuring individual airline safety.

Background

The Federal Aviation Administration (FAA), within the Department of Transportation (DOT), is responsible for assuring that airlines meet safety standards. To carry out this responsibility, FAA monitors, through periodic inspections, airline compliance with Federal Aviation Regulations which set standards for airline operations and maintenance functions.

The accident rate, which is the most widely recognized measure of overall aviation safety, indicates that U.S. airlines, as a whole, continue to operate safely. However, because accidents occur so infrequently, there are no statistically significant differences in the accident rates among similar airlines. Also, because accident rates reflect what has already happened, their relevance to accident prevention can be limited.

Current assessments of individual airline safety depend upon subjective professional judgments made by airline managers, FAA inspectors, independent airline safety auditors, and insurance underwriters. While these subjective expert assessments are valuable in reviewing and improving the safety of individual airline operations, they are not suitable for objective comparisons of airlines. Specifically, because experts can differ in their judgments, the subjective assessments of experts are not comparable from airline to airline.

FAA has identified some factors, such as major changes in an airline's operating scope or the rapid turnover of its key personnel, that make it more likely that an airline will have difficulty complying with federal

regulations. These factors, which GAO calls risk precursors, are not easily quantifiable; therefore, they are not suitable for exact comparisons among airlines. However, as GAO previously reported, they can be valuable to FAA in targeting inspection resources.

Results in Brief

GAO did not find any performance indicators that are currently usable to compare objectively the safety levels of individual airlines. Experts believe that pilot competence, maintenance quality, financial stability, and management attitude are areas important to the safety of an airline's operation. GAO identified three potential sources of information for comparable and objective measurement in these areas: FAA inspection results, FAA data bases on unsafe incidents, and a DOT data base on airline financial conditions. Data limitations currently restrict the usefulness of all three data sources in measuring individual airline safety. Because they measure compliance with Federal Aviation Regulations, FAA's inspection results could be used to measure airline safety, if FAA addresses data problems. Current information is not adequate to assess whether data on unsafe incidents or airline finances could be valid indicators of safe operation if data quality is improved.

Principal Findings

FAA Inspection Results

GAO believes that use of FAA inspection data has potential for objective comparison of individual airline safety in the areas of pilot competence and maintenance quality. FAA, however, cannot currently provide objective and comparable information about how well airlines comply with federal regulations. In two previous reports, GAO identified three main limitations in FAA's data on airline inspections.

- FAA lacks standardized inspection procedures, so inspection results are not comparable.
- FAA has no comprehensive national data base of inspection results to permit comparison among airlines.
- FAA does not have procedures for identifying and classifying the safety problems revealed by inspections to provide comparable data on significant violations of the Federal Aviation Regulations.

FAA is taking steps to address these deficiencies.

Data on Unsafe Incidents and Financial Condition

FAA maintains five data bases on different types of unsafe incidents that might be used to identify pilot or maintenance weaknesses. However, these data bases were planned as research and reference aids concerning various types of unsafe conditions and are not well suited for providing comparable information on individual airline safety. Data bases include information on near mid-air collisions, maintenance difficulties, and other potentially dangerous incidents. In particular, several factors limit their usefulness for measuring individual airline safety, including unreliable data, missing information, and inconsistent reporting practices. For example, FAA's data base on near mid-air collisions lacks information on the cause of the incident, which is an important factor in assessing whether the incident resulted from unsafe airline operations.

While the quality of the information in these data bases can be improved, these improvements may not lead to comparable and objective measures of how safely individual airlines are operating because (1) there may not be enough incidents to measure significant differences and (2) the validity of data on these incidents for measuring airline safety has not been established. At the initiative of the FAA Administrator, the agency is starting to study whether incident data bases can be used to assess airline safety. Also, DOT's Transportation Systems Center is developing a prototype information system for the Air Force and FAA that will use incident data in managing military aircraft charters. These two initiatives may contribute to better understanding of the potential use of FAA data bases in measuring airline safety.

Research does not support using financial data as a definitive indicator of the safety of individual airline operations. Several studies have examined whether an airline's financial stability affects its safety record. While some studies reveal at least a weak statistical correlation between an airline's financial condition and its safety record or compliance with FAA regulations, an equal number of the studies find no relationship between financial indicators and reduced levels of maintenance or safety. However, a previous GAO report showed how information about an airline's financial condition can help FAA target inspections toward airlines with a higher probability of compliance problems.

Ongoing Research Projects

In addition to DOT's research for the Air Force and FAA to develop a data base that can be used in managing military charter operations, GAO identified three university research projects to develop basic information on factors influencing aviation safety.

Recommendations

This report does not contain recommendations, because FAA is starting to study whether incident data bases can be used to measure airline safety and has agreed with recommendations contained in previous GAO reports to improve airline inspection procedures.

Agency Comments

GAO discussed the contents of this report with responsible agency officials, and their comments have been incorporated where appropriate. However, as agreed with the requester's office, GAO did not obtain official agency comments on a draft of this report.

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Abbreviations

AIDS	Accident and Incident Data System
DOT	Department of Transportation
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
GAO	General Accounting Office
ICAO	International Civil Aviation Organization
NATI	National Air Transportation Inspection
NTSB	National Transportation Safety Board
SDRS	Service Difficulty Reporting System

Introduction

Many factors have contributed to growing congressional and public concern over the safety of air travel, including catastrophic air crashes, highly publicized near mid-air collisions, and growing congestion at major airports. To help improve knowledge about air safety, the requesters asked us to provide information on the feasibility of developing and publishing indicators of how safely individual airlines operate.

Background

The Federal Aviation Administration (FAA), within the Department of Transportation (DOT), is responsible for assuring that airlines meet safety standards. Through Federal Aviation Regulations (FARs), FAA sets standards that airlines must follow in areas such as pilot training, aircraft maintenance, and flight operations. FAA inspectors monitor airline compliance with the FARs. FAA also operates the national air traffic control system, which monitors and directs aircraft in flight.

We issued two reports in 1987 that contained information on FAA's inspection of airlines. In April 1987, a report on DOT management issues showed how FAA could use planning techniques to target its inspection resources more effectively.[1] Our May 1987 report identified specific weaknesses in FAA's airline inspection program and described FAA's efforts to address them.[2] We make use of our earlier work in this report. (See ch 3.)

Since the deregulation of fares and schedules in 1978, the airline industry has grown rapidly, with new airlines entering the industry, and others leaving. As the industry has grown, congestion has increased around major airports, placing additional strain on the system's safety. The new airline practice of channeling many flights into major "hub" airports has further increased congestion. In response to concerns that these pressures may be lowering safety levels, aviation experts including industry executives, federal officials, and representatives of private organizations, as well as members of Congress, have called for improvements in the measurement of airline safety.

[1] Department of Transportation: Enhancing Policy and Program Effectiveness Through Improved Management (GAO/RCED-87-3, April 13, 1987).

[2] Aviation Safety: Needed Improvements in FAA's Airline Inspection Program are Underway (GAO/RCED-87-62, May 19, 1987).

Objectives, Scope, and Methodology

By agreement with Representative Boxer's office, representing the requesters, we focused our work on identifying

- areas of airline operation recognized as important to airline safety,
- the availability and quality of data in these areas, and
- ongoing research on measuring individual airline safety.

To identify available information and analyses concerning how safely individual airlines operate, we reviewed documents and interviewed officials at the National Transportation Safety Board (NTSB) and at DOT (in FAA, the Research and Special Programs Administration, and the Office of the Secretary). We also reviewed published research results and interviewed experts in aviation safety in the airline industry, professional associations, and universities to assess research on aviation safety and obtain expert opinions concerning the development of safety indicators. We obtained data on accidents and airline operations from DOT and NTSB to compare accident rates among airlines. A list of organizations and individuals that we interviewed during our work is in appendix I, and a bibliography of material on aviation safety is at the end of the report.

In identifying and assessing potential ways of measuring airline performance in areas important to safety, we looked for indicators that were comparable and objective. Comparable indicators are those that can compare the performance of different airlines. Objective indicators are those that are not dependent upon the subjective judgment of the person making the assessment. We believe indicators that could be used by the public to compare airline safety and make air travel choices should meet these standards.

The accident rate, the primary measure of aviation safety, is computed by dividing the number of accidents by a measure of the airline's activity, such as the number of operating hours, passenger miles, or departures. NTSB maintains a data base on accidents using a consistent definition and prepares records on individual accidents using a standardized format. The Research and Special Programs Administration within DOT collects and maintains data that can be used to measure the level of airline activity, including operating hours, departures, and passenger miles flown.

In computing the accident rate, we used departures as the measure of airline activity, where the information was available to do so. Some

studies that we refer to compute the accident rate using bases other than the number of departures. The bases for the accident rates are indicated in the text. The number of departures provides a good measure of exposure to accidents because most accidents are associated with the takeoff and landing phases of flight. Use of departures to compute accident rates provides a good method of comparing airlines operating large aircraft with commuter airlines because the rates are not distorted by the fact that commuters average far fewer miles between stops.

In general, data on airline operations are better for airlines operating large aircraft than for commuter airlines, for two reasons. First, DOT requires the large aircraft operators to report more data than commuter airlines. DOT requires some commuter airlines to report limited information on maintenance costs, for example, but most commuter airlines are not required to submit any financial data. In addition, DOT officials responsible for the data believe that some information reported by commuter airlines is not reliable. Currently, there are limitations on the quality of much of the data that might be used to analyze airline safety. These limitations are discussed in more detail at appropriate points in the report.

We made this review in accordance with generally accepted government auditing standards. We discussed the contents of this report with responsible agency officials, and their comments have been incorporated where appropriate. However, as agreed with the requester's office, we did not obtain official agency comments on the report.

Assessing Airline Safety

According to experts with whom we talked, as well as published research, the accident rate is the most logical and widely accepted measure of overall aviation safety, because accidents provide a direct measure of the risks of flying. The accident rate provides a comparable and objective measure of aviation safety. As stated in chapter 1, the accident rate is based on standardized data that are reported consistently, making the accident rate a consistent measure that is comparable for different types of airline and for different periods of time. The accident rate is also objective; that is, it is not dependent upon the subjective judgment of the researcher who develops it.

Accident rate data show that the safety record of U.S. airlines, as a whole, has improved over the last 20 years and that U.S. airlines have a lower accident rate than airlines in the rest of the world. Although accident rates are higher for commuter airlines than for airlines operating large aircraft, the difference has decreased in recent years.

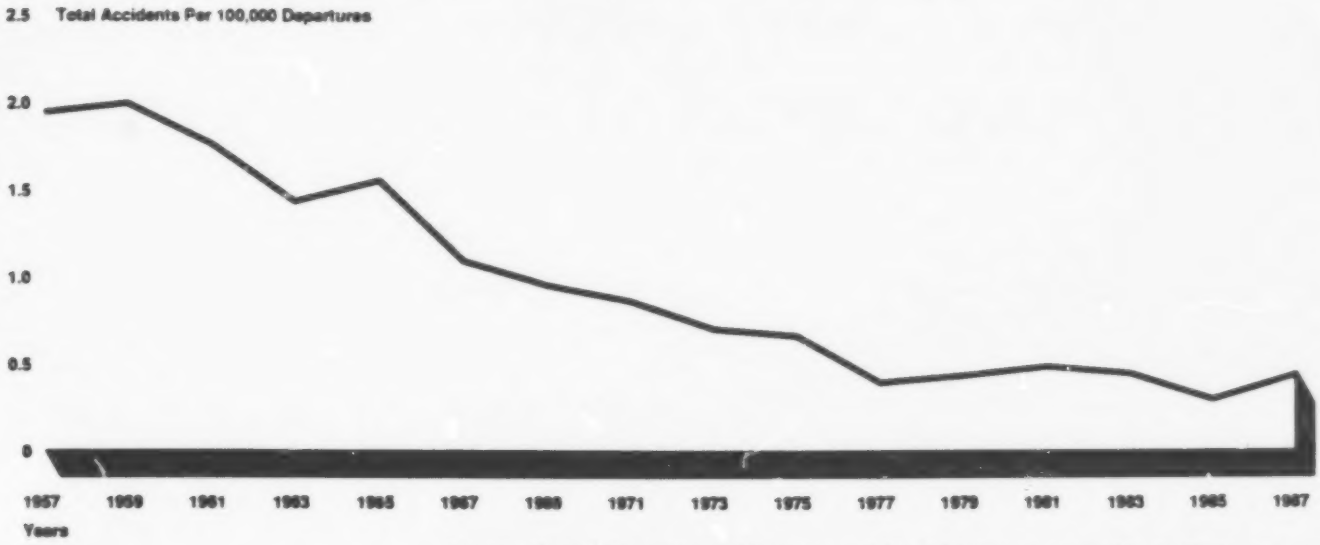
Although the accident rate is a good long-term measure of safety for major segments of the aviation industry, it is not adequate to compare how safely individual airlines are operating, because there are too few accidents to permit meaningful analysis. Officials at FAA and NTSB, university researchers, and other experts pointed out additional difficulties in using the accident rate to measure the safety of individual airlines, including problems in assessing the cause of accidents and differences in conditions faced by individual airlines. Also, the rapidly changing nature of the airline industry means that historical safety data may not be a good measure of current safety conditions. The following information on aviation industry accident rates provides background and context for discussion of how the safety of individual airlines might be measured.

Trends in U.S. Airline Accidents

As figure 2.1 shows, the accident rate for U.S. airlines operating large aircraft decreased steadily between 1959 and 1977 and has since ranged between 0.5 and 0.2 accidents per 100,000 departures. A 1987 study of the decline in accident rates between 1970-78 and 1979-85 found that there had been significant decreases in most accident causes, including equipment failure, weather, pilot error, and air traffic control, as well as

the failure of passengers to fasten seatbelts (a major cause of passenger injury).[1]

Figure 2.1: U.S. Airline Accident Rate, 1957-87 (U.S. Air Carriers Operating Under Part 121 FAR, All Scheduled Service)



Sources: Nancy L. Rose, "Financial Influences on Airline Safety," paper prepared for the Conference on Transportation Deregulation and Safety, Northwestern University, June 23-25, 1987 (1957-1974 data); NTSB (1975-1987 data)

Comparison of U.S. Airlines to Other Airlines

Data needed to compute accident rates are not easily available for most countries other than the United States because the International Civil Aviation Organization (ICAO) publishes only aggregate accident data for all countries and does not release accident data for individual countries. Using ICAO data, in 1986 DOT officials compared the U.S. airline accident rate with a composite of other airlines from 1980 to 1984 and concluded that the fatal accident rate for U.S. commercial aviation is less than one-third the rate in the other countries. Table 2.1 shows the fatal accident rate for U.S. airlines and other airlines from 1980 to 1985.

[1]Clinton V. Oster, Jr. and C. Kurt Zorn, "Air Deregulation: Is It Still Safe to Fly?", unpublished draft prepared for presentation at the Transportation Deregulation and Safety Conference, Northwestern University, June 23-25, 1987, p. 23.

Table 2.1: Comparison of U.S. And Other Airlines (Fatal Accidents Per 100,000 Aircraft Departures)

Year	U.S.	Other[a]
1980	0.11	0.38
1981	0.19	0.27
1982	0.11	0.57
1983	0.08	0.48
1984	0.10	0.28
1985	0.13	0.32

[a]Based on ICAO data which exclude the U.S.S.R. and from which U.S. data have been subtracted.
Source: Office of Transportation and Regulatory Affairs, DOT (unpublished data), for 1980-84. 1985 rates calculated from NTSB and ICAO data.

A 1987 study[2] documents that U.S. airlines continue to have a low accident rate compared with those of other countries, on the basis of flying hours. At the beginning of 1987, European airlines had a jet aircraft destroyed by accident about twice as often as U.S. airlines. Airlines in Canada, Asia, Africa, and Central and South America had jet aircraft destroyed by accident about four times as often as U.S. airlines.

The low accident rate of U.S. airlines compared with other airlines is a long-standing pattern. A 1973 study[3] concluded that the United States was one of only two countries with an accident rate significantly below the worldwide average. (The other country was the Netherlands.)

Accident Rates for Different Types of U.S. Airlines

The U.S. domestic, commercial airline industry is divided into two main groups of common carriers. One group consists of operators of large aircraft who are subject to Part 121 of the FARs. Aircraft in this category carry 30 or more passengers or a cargo payload of at least 7,500 pounds. The second group of airlines, often referred to as "commuter" airlines, operates smaller, propeller-driven aircraft, which carry fewer than 30 passengers and a payload of less than 7,500 pounds. The airlines in this second group are covered by Part 135 of the FARs.

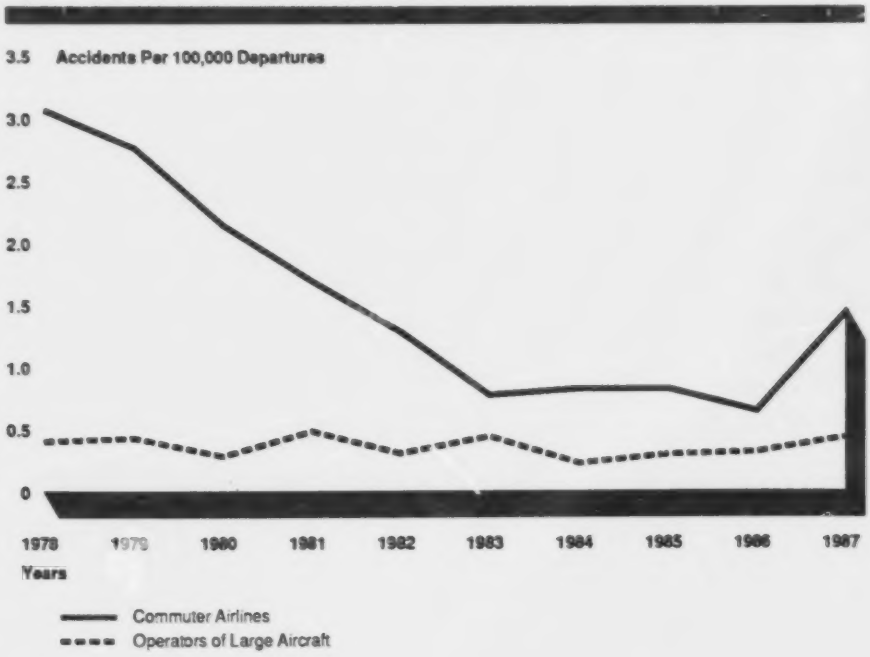
As figure 2.2 shows, the accident rate for commuter airlines has been higher than for airlines operating large aircraft. Figure 2.2 also shows that the accident rate for commuter airlines dropped steadily from 1978

[2]Mack W. Eastburn, "A Management Tool: The Accident Record," prepared for the Fourth International Aircraft Cabin Safety Symposium of the Institute of Safety and Systems Management of the University of Southern California (unpublished).

[3]"Towards an Overall Safety Index?" Flight International, November 28, 1974, pp. 768-769.

to 1986 before increasing in 1987, while the accident rate for Part 121 air carriers has been about the same.

Figure 2.2: Comparison of Accident Rates of Commuter Airlines with Operators of Large Aircraft, 1978-87



Source: NTSB.

A 1987 study of the commuter airline industry[4] concluded that the accident rate for the larger commuter airlines was much lower than for smaller commuter airlines during 1979-85. The 20 largest commuter airlines had a rate of 0.67 fatalities per million passenger enplanements, while the rate for the next 30 commuter airlines was 1.21 fatalities per million enplanements. The rate for the remaining commuter airlines was 4.08 fatalities per million enplanements. In comparison, the study found that the accident rate for established airlines flying large aircraft during the same period was 0.38 fatalities per million enplanements.

[4]Clinton V. Oster, Jr. and C. Kurt Zorn, op. cit., p. 20.

Factors Important to Airline Safety

While the accident rate is a good safety measure for major segments of the aviation industry, it cannot be used to compare how safely individual airlines are operating, because there are too few accidents to permit meaningful analysis. As a result, at the present time, assessments of individual airline safety are subjective. Because of the many complex problems that must be addressed to operate an airline safely, experts must use subjective judgment in evaluating how well an airline is operating in areas important to safety. For example, experts who had performed safety audits on individual airline operations told us that professional judgment was necessary to form an overall assessment of the competence of an airline's pilots or the quality of its maintenance programs. Similarly, airline insurance experts whom we interviewed said that they had to rely on personal judgment in assessing airline safety because no objective measures existed that could be used to compare how safely airlines operated. Airline managers and FAA inspectors also make subjective assessments of how safely individual airlines are operating. The subjective assessments of experts are not comparable from airline to airline because experts can differ in their judgments.

As a starting point for developing alternative measures of individual airline safety, we identified four aspects of airline operations that experts generally agree are very important to safe operations—pilot competence, maintenance quality, financial stability, and management attitude—and determined if comparable and objective information on the safety of individual airline operations in these areas could be developed. We did not find any experts who believed that there were now any comparable and objective measures of airline safety in these four areas. The following sections describe how pilot competence, maintenance quality, financial stability, and management attitude affect airline safety, and also identify difficulties that hinder the development of comparable and objective measures of airline safety in each area.

Pilot Competence

Pilot performance is a key factor in many accidents. A study by the Boeing Corporation found, for example, that errors by the flight crews were the primary cause of over 70 percent of the accidents that resulted in the loss of Boeing built aircraft between 1959 and 1985.[5] Pilot and crew training is an important function in all airlines. Concern over pilot competence has increased in recent years as airline expansion resulted in the use of pilots with less and less experience.

[5]L. G. Lautman and P. L. Gallimore, "Control of the Crew Caused Accident," Boeing Airliner, April-June, 1987, pp. 1-7.

Experts that we interviewed pointed out the difficulty of assessing the competence of an airline's pilots. Although airlines must maintain pilot training programs that meet FAA approval, the airlines differ in how they perform training. The research director for the Air Line Pilots Association noted the extreme difficulty of providing overall assessments of the training programs of individual airlines, as did university researchers and an NTSB staff member. For example, one university faculty member said that:

"Although airline pilot training is heavily regulated and each airline's training program is very similar, the methods of applying training and measuring the results are all different."

He also said that it is very difficult to relate flying experience to the accident rate.

Maintenance Quality

Maintenance quality is another area regarded as important to airline safety. Under FAA regulations, all airlines must have comprehensive and systematic maintenance programs. Since deregulation, two factors have increased concern over how well airlines maintain their fleets. First, as airlines have made increasing use of contractors to perform maintenance, FAA has identified new airline management problems and encountered inspection difficulties. Second, as airlines have made more intensive use of their aircraft, FAA has found that there has been less time available for maintenance functions because of tighter scheduling requirements.

Although maintenance quality is regarded as an important factor in airline safety, it appears very difficult to measure the maintenance quality of individual airlines. One measure of maintenance quality might be the maintenance problems encountered by the airline. Although FAA has data bases on maintenance related problems, they have data quality problems, as discussed in chapter 4.

Some measures proposed as maintenance quality indicators could put pressure on airlines to operate unsafely. For example, flight delays due to mechanical problems might be regarded as an indicator of ineffective airline maintenance procedures. However, if flight delays due to mechanical problems were used to compare airline maintenance quality, this could lead airlines to takeoff without fixing some problems. This consideration was an important factor in DOT's decision not to require public reporting of this data, according to an FAA official.

Although larger airlines must report maintenance costs to DOT, these reported costs may not be a good measure of the maintenance effort of an airline because airlines differ in their labor costs and accounting practices, as well as in the age of their aircraft fleets. For example, an airline with a newer fleet may need to spend less on maintenance because newer aircraft require less maintenance. Because DOT does not require smaller airlines to report maintenance costs, the maintenance effort of these airlines cannot be measured at all. The difficulty of using maintenance costs to judge an airline's safety performance is illustrated in a 1987 study[6] that found that between 1955 and 1983, airlines that spent more on maintenance per mile flown actually had a higher accident rate than other airlines.

Financial Stability

Since deregulation, some aviation safety experts have contended that the pressures of economic competition might lead airlines to spend too little on safety functions. An airline in financial difficulty might not be able to finance adequate training and maintenance programs, for example. Since deregulation, much of the university research on airline safety has focused on whether the financial health of airlines can be related to the safety of their operations. FAA has identified the financial condition of an airline as an important consideration in determining whether more intensive inspection surveillance is needed.

Researchers have used financial data submitted to DOT by airlines to analyze the relationship between an airline's financial condition and its safety record. The use of DOT's financial data base to measure airline safety is discussed in chapter 4.

Management Attitude

Airline executives, university researchers, and other experts identified management's attitude toward safety as important to assessing how safely an airline is operating. Management emphasis on safety is necessary to assure that all aspects of airline operations are performed in ways that minimize safety risks. While stressing the importance of management attitude toward airline safety, the experts agree that management attitude is basically judgmental and subjective, and cannot be quantified.

[6]Nancy L. Rose, "Financial Influences on Airline Safety," paper prepared for the Conference on Deregulation and Transportation Safety, Northwestern University, June 23-25, 1987, p. 18.

Measuring Airline Safety

As the preceding sections show, many problems hinder the development of comparable and objective measures of factors recognized as important to aviation safety. While some experts believe that it is possible to form an overall assessment of an airline's management attitude toward safety, or the overall quality of its training program, these assessments are subjective, rather than objective, in nature, and are not susceptible to quantification.

Chapters 3 and 4 examine possible approaches to developing comparable and objective measures of the safety of individual airline operations. Chapter 3 analyzes the potential of FAA inspection results as an indicator of airline safety, while chapter 4 looks at DOT data bases on unsafe incidents and airline finances. We identified several ongoing research projects related to the measurement of airline safety, which are described in chapter 5. Most of this research focuses on the effect of an airline's financial condition upon the safety of its operation.

FAA Inspection Results Are a Potential Measure of Individual Airline Safety, but Improvements Are Needed

The U.S. airlines operate according to FARs issued by FAA. FAR requirements cover areas we identified as important to safe airline operation, particularly pilot competence and maintenance quality. In the opinion of FAA managers, the FARs also address an airline's financial stability and management attitude, although less directly, since adequate financial resources and management emphasis on safe operation are necessary if an airline is to comply with the specific requirements of the FARs.

FAA regards compliance with the FARs as the most important measure of how safely an airline is operating and inspects airlines to assure that they are meeting the requirements of the FARs. Over the past 2 years FAA fined individual airlines up to $9.5 million for failing to comply with the FARs. In addition, it has suspended the operating licenses of several smaller airlines as a result of its inspections during the same period. Aviation safety experts outside FAA also agree that compliance with the FARs is an important factor in measuring how safely an airline is operating.

Because they assess compliance with the FARs, FAA inspection results have potential for use as comparable and objective measures of airline safety in the areas of pilot competence and maintenance quality—two areas addressed directly in the FARs. Currently, however, well documented problems limit the worth of inspection results in measuring how safely an airline is operating. FAA is taking actions that should make its inspection results more comparable and objective measures of airline safety.

Limits on the Comparability and Objectivity of FAA's Airline Inspection Results

FAA does not now have objective and comparable information about how well airlines comply with the FARs, according to reports that we issued in April and May, 1987.[1] We found three main limitations on FAA's data on airline inspections. FAA: (1) lacked standardized inspection procedures, so inspection results were not comparable among inspectors and district offices; (2) had no comprehensive national data base of inspection results to facilitate their analysis; and (3) did not have procedures for evaluating and classifying the safety problems revealed by inspections in order to provide comparable data on significant violations of the FARs.

Our May 1987 report identified problems in FAA's airline inspection program that limited the objectivity and comparability of its inspection

[1]GAO/RCED-87-3, April 13, 1987, and GAO/RCED-87-62, May 19, 1987.

results. The guidance to FAA's inspectors, for example, was not sufficiently comprehensive and understandable to assure that inspectors in different district offices performed inspections in comparable ways. Also, inspectors were not adequately trained in inspection procedures.

This report also identified deficiencies in the data base that FAA maintains on inspection results. In addition to data accuracy problems and computer hardware limitations, FAA had not yet developed a national data base of its recent inspection results that permits the systematic comparison of all airline inspection results. FAA now has nationwide data on inspections performed to meet FAA's minimum inspection requirements. The minimum requirement levels, however, are only a small portion of the total number of inspections performed on larger airlines.

Quality control in the reporting of inspection results has also been a problem. For example, a panel reviewing the results of FAA's 1984 National Air Transportation Inspection (NATI), a comprehensive nationwide inspection of the airline industry, found deficiencies in the quality of over 40 percent of inspection reports. Our review of inspection reports found similar quality problems, as we reported in May 1987. Acknowledging these problems in inspection quality, FAA managers attributed them to inadequate supervisory staffing and poor guidance and training.

Improving the Quality of Information on FAA Inspection Results

FAA agreed with the recommendations to improve the quality of data on inspection results contained in our previous reports and is working to address deficiencies that limit the usefulness of its inspection results. It has established a comprehensive, long-term approach to improving the management and operation of its airline inspection program, with particular emphasis on preparing handbooks and developing inspector training courses to assure more consistency in the performance of inspections. FAA is taking steps to improve its data base on inspection results. A central component of FAA's strategy is improving the computer equipment at its district offices, a major effort that is not planned to begin until the middle of 1988 at the earliest. Currently, FAA does not have specific target dates for establishing a nationwide data base on inspection results using the new computer equipment.

As we reported in April 1987, FAA can take additional steps to improve the usefulness of its inspection results in comparing airline safety performance by characterizing the seriousness of deficiencies identified

during inspections. In analyzing airline inspection results, it is important to be able to assess the significance of the violations of regulations identified during the inspections. Eastern Airlines claimed, for example, that many of the infractions that led to the record $9.5-million fine were trivial "paperwork" violations. While the FAA Administrator agreed that many of the violations involved recordkeeping, he said that such recordkeeping was a "small but important" item. To help resolve such controversies, FAA could characterize the seriousness of inspection deficiencies to help FAA and others assess and compare inspection results.

Our April 1987 report on DOT's management showed that techniques developed by FAA to analyze the NATI inspection results in 1984 could be used to develop comparable data on inspection results. After preparing a comprehensive data base of over 13,500 NATI inspections, FAA analyzed the deficiencies reported during its inspections and classified them into three levels according to their seriousness for safety. A similar classification of current inspection deficiencies could lead to greater comparability and objectivity in inspection results.

We believe that FAA can improve the quality of its inspection results as a safety indicator if it adopts procedures for focusing its inspection work force on airlines with high potential for FAR compliance deficiencies. In our April 1987 report, we showed how FAA could use factors identified in its 1984 NATI study to determine which airlines needed the most intensive inspection. (While we used FAA's program as an example of how planning could be improved, our formal recommendation was directed toward improving DOT's management as a whole, rather than toward specific FAA activities.) Factors that FAA could consider in planning inspection coverage include:

- A major change in operating scope, such as significant route expansion, fleet expansion, or introduction of a new type of aircraft.
- A relatively large amount of maintenance and/or training done by outside contractors rather than in-house.
- Inadequate internal audit procedures to assure self-compliance with safety policies, practices, standards, and federal regulations.
- Financial, labor-management, or other corporate problems such as rapid turnover of key personnel.
- Management skills and philosophy incompatible with sound practices, such as slighting safety for the sake of marketing or financial considerations.

These factors, which we called risk precursors, are not easily quantifiable, and so cannot be used as comparable and objective measures of individual airline safety. However, by monitoring these risk precursors, FAA could target for intensive inspection those airlines most likely to experience safety compliance problems, thereby improving the quality of information available on the airlines' compliance with the FARs.

Use of DOT Data Bases to Measure Individual Airline Safety

DOT's data bases may be useful in developing measures of aviation safety, according to some safety experts. University researchers and other experts have identified FAA data bases on unsafe incidents as possible starting points for measuring individual airline safety. Also, airline financial data maintained by DOT's Research and Special Programs Administration is a primary source of information for research on whether the financial stability of an airline affects its safety performance.

None of FAA's incident data bases can currently provide a satisfactory basis for developing indicators of how safely individual airlines are operating because the data are unreliable, important information is missing, reporting practices are inconsistent, and the safety significance of specific incidents is difficult to assess. FAA is considering how the quality of these data bases can be improved.

DOT's data base on airline finances has been used for research on how financial stability affects airline safety, and research continues. While some studies reveal at least a weak statistical correlation between an airline's financial condition and its safety record or compliance with FAA regulations, an equal number of the studies find no relationship between financial indicators and reduced levels of maintenance or safety.

FAA Data Bases on Unsafe Incidents

There has been widespread newspaper and television coverage of unsafe airline incidents that have not resulted in accidents, particularly some heavily publicized near mid-air collisions between airliners. While these incidents may be dangerous, they do not result in substantial damage to the aircraft or serious injury to their occupants. Because these unsafe events occur much more often than accidents, several experts suggested that analysis of unsafe incidents or "non-accidents" could lead to useful safety indicators if ways could be found of measuring and comparing them. The unsafe incidents recorded in FAA data bases might indicate weaknesses in areas important to safe airline operation, such as pilot competence or maintenance quality.

In October 1987, at the initiative of its new administrator, FAA began to evaluate its incident data bases as a source of information on airline safety. The evaluation is in the preliminary stages, and no specific plans of action have yet been developed.

FAA maintains several data bases on unsafe incidents that occur during airline operations.

- The Accident and Incident Data System (AIDS), which is the most comprehensive data base, contains information on accidents as well as a wide range of other unsafe events. This data base includes incidents that could reflect either lack of pilot competence or maintenance quality. For example, the data base includes incidents where a pilot runs off the runway while landing, or a takeoff is aborted for mechanical reasons.
- The Near Mid-Air Collision data base contains pilot reports of apparently dangerous encounters with other aircraft during flight.
- The Pilot Deviation data base, now under development by FAA, contains incidents in which pilots fail to respond to air traffic control directives.
- The Service Difficulty Reporting System (SDRS) contains airlines reports of equipment malfunctions and other maintenance problems like unanticipated failures in engine parts.
- The Aircraft Utilization and Propulsion data base has information on engine problems in flight, such as engine shutdowns.

Accident and Incident Data Base

The AIDS data base is the broadest data base FAA maintains on unsafe occurrences in aviation. Individual FAA inspectors' reports are the source of AIDS data, which covers an extremely wide range of aviation incidents. For example, one reported incident in 1986 concerned an airliner's losing cabin pressure, while a second involved a pilot's landing when the weather was below minimum requirements. The FAA data base manager estimated that about 3,000 reports concerning airlines are entered in AIDS each year.

FAA analysts have not attempted to use AIDS data to develop any comparative measures of individual airline safety and were not aware of anyone else who has tried to do so. The Manager of FAA's Safety Analysis Division pointed out that because many different kinds of incidents are contained in the data base, subjective judgment is required to assess whether the incident really indicates that the airline is operating unsafely. As a result, different analysts could easily reach different conclusions about how safely an airline was operating.

The AIDS data base manager said that there is no effective quality control over reports submitted by inspectors and that some data contained obvious errors. His unit lacks resources to follow-up reports to correct errors. Thus, the incident data base is inconsistent and incomplete.

Near Mid-Air Collisions Data Base

As noted previously, near mid-air collisions between airliners are widely publicized examples of unsafe operation. Although some near mid-air collisions are initially reported by FAA's air traffic controllers, most are reported by one or both of the pilots involved. The number of near mid-air collisions reported annually has risen from 475 in 1983 to 857 in 1987. Of the 857 near mid-air collisions reported in 1987, FAA determined that 383 involved at least one commercial airliner and only 38 involved two airliners. About 80 percent of the near mid-air collisions involved private, general aviation aircraft. FAA's data base manager said that changes in reporting procedures were an important factor in the increased reporting levels. In 1985, FAA changed its follow-up procedures, which led its inspectors to submit more reports.

Although FAA has used the data base for some analysis of aviation safety, the agency has not used it to analyze individual airline safety. Several characteristics limit this data base's usefulness as an indicator of how safely an individual airline is operating. The most important limitation is that data base records do not indicate the cause of the near mid-air collision. Without information about cause, determining which aircraft was operating unsafely is impossible, or whether some other reason was the cause for the near collision. FAA is currently considering whether to add this information to the data base. Another limitation on its usefulness is the semivoluntary nature of the reports entered in the data base. As noted earlier, recent changes in FAA's reporting practices have contributed to the increase in the number of near collisions reported to the data base, a factor that limits the validity of any trend analysis.

Pilot Deviation Data Base

Since 1985, FAA has maintained a data base on air traffic control incidents detected by its computers. These incidents occur when two aircraft come closer together than the prescribed limits. FAA is developing a data base of pilot deviations, which are defined as those incidents that result from the pilot's actions, rather than the traffic controller's. For example, incidents where pilots fly at 31,000 feet after being instructed to fly at 30,000 feet will be included in this data base. In the future, the pilot deviation data base may become a source of information on potentially unsafe actions by airline pilots.

Service Difficulty Reporting System

SDRS contains information on equipment problems and maintenance difficulties encountered by airlines and private aircraft operators. Airlines submit about 15,000 SDRS reports each year.

Although FAA regulations specify the types of problems that airlines must report, directors of research at an airline and at the Air Line Pilots Association said that airlines varied greatly in the data that they report to SDRS. FAA managers of the data base said that they had not taken any steps to assess reporting consistency among airlines and agreed that there were probably differences in reporting practices.

Aircraft Utilization and Propulsion Data Base

This data base contains information on engine problems during flight. Monthly reports are submitted by airlines on the number and type of their airplanes and engines, their level of usage, and on engine problems, such as shutdowns, that took place during the month. In addition to creating the risk of an accident, engine problems in flight may also be a potential indicator of weaknesses in an airline's maintenance program.

The manager of the data base said that its main function was to provide long-term trend analysis on the performance of equipment and that they had not attempted to analyze differences in performance among individual airlines.

The research director of the Airline Pilots Association said that the data base was limited because it did not contain information on engine problems encountered during startup and taxiing, before the plane actually left the ground. According to the research director, the absence of this information seriously restricted the data base as a potential indicator of the maintenance performance of an airline. The FAA data base manager agreed that airlines could differ in their reporting practices. As a result, data may not be consistent among airlines. The Manager of FAA's Safety Analysis Division said that a problem in comparing data between airlines was that airlines have different mixes of equipment; therefore, it is difficult to compare overall engine failure rates.

FAA's Incident Data Bases and Individual Airlines Safety

We could not identify any published research that had investigated the use of FAA incident data to assess individual airline safety. Two research projects plan to make use of some of these data bases in future work, as described in chapter 5. The documentation describing the contents and operation of these data bases was inadequate and difficult to obtain. FAA officials required several weeks to provide us information describing the data bases, and the information finally provided was inadequate to assess the usefulness of the data bases for research purposes. FAA officials said that these data bases are intended primarily for looking at

specific safety problems (such as aircraft design flaws) and were not designed for analyzing the safety of individual airline operations.

Two experts expressed doubt that the number of incidents would be sufficient to permit statistically valid comparisons among airlines, while airline industry representatives questioned whether currently reported data could be the basis for maintenance quality indicators. The Manager of the FAA Safety Analysis Division agreed that research would be needed to validate unsafe incidents as indicators of airline safety.

DOT Data Bases on Airline Finances

Since deregulation, some aviation safety experts have contended that the pressures of economic competition under deregulation might lead airlines to spend too little on safety functions. An airline in financial difficulty might not be able to finance adequate training and maintenance programs, for example. Since deregulation, much of the university research on airline safety has focused on whether the financial health of airlines can be related to the safety of their operations. FAA has identified the financial condition of an airline as an important factor to consider to determining whether more intensive inspection surveillance is needed.

DOT's Research and Special Programs Administration compiles data submitted by airlines on their operations and financing, which is the main evidence for study of an airline's financial condition. Airlines flying airplanes with a capacity of more than 60 passengers submit the most extensive information, while airlines with fewer passengers are required to submit much less information. Many commuter airlines are not required to submit any financial data at all.

Because DOT collects much less financial data on commuter airlines than it does on airlines operating larger aircraft, it is difficult to analyze the financial condition of the commuters. A university faculty member who had performed extensive research on commuter airline safety told us that the financial data were inadequate to compare financial conditions of individual airlines.

Lack of data is also an important limitation in analyzing the financial condition of airlines operating large aircraft. A 1986 study of NATI

inspection results[1] found that of the 303 airlines inspected, only 103 were represented in DOT's financial data base. Of these 103, only 59 had financial data for the relevant time periods.

Studies of the effects of an airline's financial condition on its safety record have produced mixed results. One study, completed by DOT staff in 1986,[2] did not identify any relationship between an airline's financial condition and its maintenance expenditures. This study was an update of a 1979 study with similar results.[3] Another 1986 study[4] concluded that the financial strength of airlines was not related to their accident rate for the years 1963-70. On the other hand, an FAA sponsored study[5] found that the performance of airlines in the 1984 NATI inspections was related to their financial condition. A study completed in 1987[6] concluded that between 1955 and 1983, there was at least a weak relationship between airline profitability and accident rates.

[1]Advanced Technology, Inc., An Evaluation of the Relationship Between Air Carrier Financial Condition and Safety Posture, prepared for the Federal Aviation Administration under Contract DTFA01-84-R-09598, April, 1986.

[2]Peter Belenky, "Preliminary Investigation of the Statistical Relationship Between Airline Finances and Maintenance, 1976-1984," May 7, 1986 (unpublished).

[3]David R. Graham and Marianne Bowes, "Do Finances Influence Airline Safety, Maintenance and Services," Report to the Civil Aeronautics Board under Contract 78-C-60, April 16, 1979.

[4]Devra L. Golbe, "Safety and Profits in the Airline Industry," Journal of Industrial Economics, March 1986, pp. 305-318.

[5]Advanced Technology, Inc., op. cit.

[6]Rose, op. cit.

Research on Airline Safety

We identified the following ongoing research that may result in more information concerning how safely individual airlines operate. None of the research efforts is directed specifically toward developing objective and comparable indicators of how safely individual airlines operate. The first research project, sponsored by Military Airlift Command in the Air Force and FAA, has the goal of developing an information system to be used in managing military charter operations. The remaining three projects are university research efforts to develop basic information on factors influencing aviation safety.

The Air Force and FAA are funding a project at DOT's Transportation Systems Center to develop a data base that can be used to manage surveillance programs to assure the safety of military charter aircraft. The project, which began in November 1986, is developing a data base that will contain information on many aspects of airlines operating military charters, including selected financial, operational, and maintenance and safety performance indicators. A prototype data base was tested in August 1987, and plans call for an operating data base to be developed by July 1988. This data base will be used to assist the Military Airlift Command in managing its contracts with commercial airlines to transport military personnel. As part of this effort, researchers are analyzing FAA's AIDs data base to develop information on airline performance, which will be included in profiles of the airline's operation.

The Transportation Research Center at Indiana University is conducting research on factors influencing airline safety, particularly commuter airlines. Its current research effort, which began in January 1987, is focusing on factors that contribute to accidents for different types of airline.

Two faculty members at the University of California, Berkeley, are studying whether new airlines are operating more or less safely than older airlines. In addition to comparing their accident rates, the researchers are analyzing other factors including maintenance expenditures, performance on federal safety inspections, and near mid-air collisions.

A faculty member at the Massachusetts Institute of Technology is analyzing the effect of an airline's financial condition on its safety performance. The research is based on a model that relates profitability and other financial variables to accident rates.

Conclusions

The accident rate, the most logical and widely accepted measure of aviation safety, provides comparable and objective measurement of overall aviation safety. Accident rates, however, cannot measure differences in the safety levels of individual airlines—because there are too few accidents to show significant differences among airlines. Accident rates indicate that U.S. airlines operate very safely compared with airlines in other countries and that airlines are operating more safely than in the past.

Airline safety procedures are monitored and improved in several ways, but the techniques now used do not produce objective, comparable measurements among airlines. Safety is an important goal of airline managers. Also, the FAA works to monitor and maintain the safety of airline operations through inspections to assure compliance with the FARs. Further, experts perform safety audits on airline operations, and insurance brokers analyze the safety of airline operations as part of their underwriting responsibilities.

As we stated in our report on DOT management issues,[1] FAA has identified some factors, such as major changes in an airline's operating scope or the rapid turnover of its key personnel, that make it more likely that an airline will have difficulty complying with federal regulations. These factors, which we called risk precursors, are not easily quantifiable so they are not suitable for exact comparisons among airlines. However, they can be valuable as a way for FAA to target inspection resources.

Experts generally agree that four aspects of airline operations are important to airline safety: pilot competence, maintenance quality, financial stability, and management attitude. Many difficulties hinder comparative and objective measurement of airline performance in these areas. Management attitude, for example, is such an intangible quality that comparable and objective measurement is virtually impossible.

An airline's financial condition has often been identified as important to safety, and we have previously reported how information on the financial condition of airlines can help FAA target airlines that are likely to have compliance problems for inspection. While the financial condition of airlines is more susceptible to comparable and objective measurement than management attitude, completed research has not demonstrated relationships between specific financial indicators and airline safety performance. Some studies reveal at least a weak statistical correlation

[1]GAO/RCED-87-3, April 13, 1987.

between an airline's financial condition and its safety record or compliance with FAA regulations, but an equal number find no relationship between financial indicators and reduced levels of maintenance or safety. University research is continuing on the effect of an airline's financial condition on its safety performance. Because financial data on commuter airlines are limited and unreliable, research on financial issues is very difficult in this sector of the industry.

In the areas of pilot competence and maintenance quality, FAA inspection results have potential for use as comparable and objective measures of airline safety because they assess compliance with FARs, which set safety standards. The FARs address areas recognized as important to airline safety, including pilot competence and maintenance quality. However, at the present time, well documented problems limit the worth of inspection results as a measure of individual airline safety. FAA has established a comprehensive, long-term effort to make needed improvements in its inspection program, particularly through improved guidance in conducting inspections and by better inspector training.

FAA is also taking steps to improve its data base on inspection results. Procedures developed during FAA's special 1984 NATI inspection show how a comprehensive data base of inspection results can be used to analyze safety problems by classifying deficiencies identified during inspections according to their seriousness. A comprehensive data base of recent inspection results, together with a way of classifying inspection deficiencies, would make the results more useful for measuring individual airline safety, as we showed in our April 1987 report.

Although inspection results have potential as a comparable and objective measure of airline safety, it is not possible to foresee what practical applications might result if the potential is realized. While inspection results might reveal significant differences in how well individual airlines are complying with the FARs, it is also possible that better inspection results data may not show significant differences in airline safety levels. At a minimum, however, we believe that improved data on inspection results could provide more objective and comparable data on how well individual airlines are performing functions recognized as important to safe operation.

FAA data bases on unsafe incidents have also been suggested as a source of information on pilot competence and maintenance quality. Current limitations on these data bases include unreliable data, missing information, inconsistent reporting practices, and difficulty in assessing the

safety significance of specific incidents. FAA can address current limitations in its unsafe incident data bases. However, these improvements may not lead to objective measures that could be used to compare airline safety, because there may not be enough incidents for statistically valid analysis and the safety significance of some data has not been established.

Actions now underway may contribute to a better understanding of the potential use of FAA incident data bases in measuring airline safety. FAA is starting to study the usefulness of the incident data bases in measuring safety. Also, DOT's Transportation Systems Center is using incident data in its prototype management information system for military charter operations, and its work may produce greater knowledge about how well incident data measure safety.

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Organizations and Individuals Contacted During Our Work

Organizations	Air Line Pilots Association Air Transport Association American Airlines Associated Aviation Underwriters Aviation Research and Education Foundation Aviation Safety Institute Boeing Corporation Flight Safety Foundation Midway Airlines Public Citizen Regional Airline Association United Airlines
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